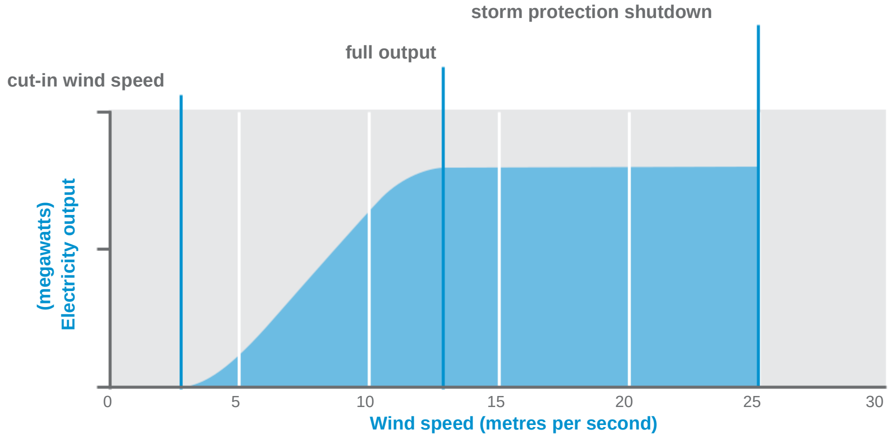
Electricity Supply and Wind Generation

Electricity is fundamental to our society and economy. Maintaining a secure, reliable supply of electricity at a reasonable cost is essential for New Zealand's economy.

Wind energy currently provides about 4% of New Zealand's electricity, with all renewable energy resources providing about 75% of total generation.[1] The New Zealand Government has set an aspirational target of 90% of all electricity coming from renewable resources by 2025. Given the scale and high quality of NZ's wind resource, wind is likely to be supplying 20 percent of our electricity by 2030.

Increased wind generation will bring with it benefits such as increasing diversity in sources of generation, reducing the impacts of dry years (years with low water flows into hydro lakes), minimising the effect of rising fossil fuel cost on electricity prices.

TYPICAL POWER CURVE OF A WIND TURBINE



SECURITY OF SUPPLY AND WIND ENERGY

New Zealand has an abundant supply of renewable resources. Making greater use of these renewable resources to balance our hydro generation will provide us with long term energy security by diversifying our sources of electricity generation.

Reliance on any one form of generation brings with it problems. New Zealand has sufficient generating capacity to meet peaks in demand. However, because we rely heavily on hydro generation, having sufficient energy (in the form of stored water) to generate electricity is not certain in dry years.

In a dry year, every megawatt-hour of wind generation would mean one megawatt-hour of energy left stored in our hydro lakes. This stored energy could be used to meet peaks in demand or to balance wind's natural variability.

Overseas, many countries are seeking to increase their use of local, renewable wind resources to reduce their reliance on thermal generation. They see wind energy as increasing their long term energy security because it helps to:

- ›› provide certainty in electricity prices as the cost of wind energy is not affected by rising fossil fuel prices
- ›› reducing reliance on constrained supplies of fuels
- ›› diversify the sources of electricity generation.

If New Zealand were to make greater use of thermal generation to balance our hydro we would expose ourselves to the price and supply uncertainties that affect electricity prices in other countries.

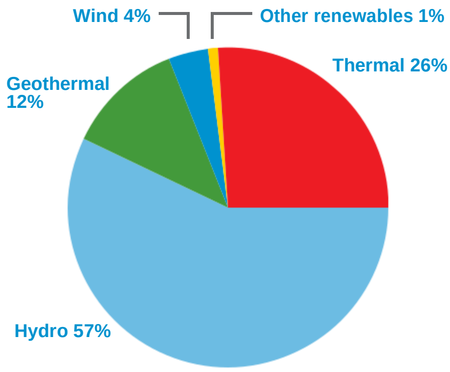
VARIABILITY OF WIND GENERATION

The energy in the wind increases with wind speed (when the wind's speed doubles, its energy content increases by eight) so a wind turbine will generate more electricity as the wind speed increases. This relationship results in a variable supply of electricity from wind farms (see Typical Power Curve of a Wind Turbine).

This variability is not necessarily a problem as modern wind turbines are designed to provide a smooth supply of electricity from a turbulent fuel source - the wind.

Modern wind turbines can alter their generation very quickly, responding to gusts by turning their blades into or out of the wind. If the wind speed increases suddenly a wind turbine's control system will make automatic adjustments to prevent surges in electricity output. As turbines are arranged over a large area in a wind farm, often stretching several

ELECTRICITY GENERATION (OCTOBER 2009 TO SEPTEMBER 2010)



Source: New Zealand Energy Quarterly, September Quarter 2010, Ministry of Economic Development.

1. Ministry of Economic Development data

kilometres, a gust of wind won't affect all of the turbines at the same time. For example, generation will ramp up during the time it takes a front to pass through a wind farm.

Wind speeds can be predicted days and hours ahead, and the output of a wind farm can be forecast in advance. Generation from other sources can be planned to accommodate expected fluctuations in wind generation. Hydro generation is particularly good for balancing wind generation as its energy can be stored (in the form of water in a hydro lake), and electricity output can be altered quickly.

It is highly unlikely that shifts in wind patterns would give rise to instantaneous power changes as large as those currently managed when a thermal generator goes off line because of a fault.

WHAT ABOUT WHEN THE WIND DOES NOT BLOW?

New Zealand is a windy country – a wind turbine here will produce electricity for about 90% of the time.

The geographic dispersion of wind farms results, overall, in a less variable supply of wind generated electricity. At the moment, a large portion of New Zealand's wind generation is concentarated in the Lower North Island, and is subject to similar weather patterns. As wind farms are developed throughout New Zealand we will see less variability in total wind generation. A study that looked at wind speeds at proposed wind farm sites through out New Zealand found that over a year, the wind was always strong enough for wind generation somewhere in the country.[2]

On a quarterly and annual basis wind generation is much more consistent than hydro. As energy sources are managed on an annual time frame (we talk about dry years, not dry days or minutes) it is this longer term consistency that is important.

Wind energy has a natural synergy with New Zealand's existing hydro resources. If we use wind's energy when it is available, then we can save the water stored in our hydro lakes. This stored water gives us more choices for generating electricity. We can:

- save the water to use another day – perhaps when low levels of wind generation or water inflows are expected
- use the water to meet fluctuations or daily peaks in demand
- use hydro instead of thermal generation to meet normal levels of demand.

THE ROLE OF RESERVES

The need for reserves, or back up generation, is not unique to wind generation. Short term variations in wind generation are just one of many components of supply and demand that are considered when setting reserve levels.

Operating an electricity system is all about managing risks, and what matters most is the overall risk. Over short timeframes, an electricity system is managed to minimise interruptions to supply caused by constantly varying demand, equipment failure, the weather, operational error and other factors. Over longer timeframes, a system is managed to ensure there is enough generation capacity to meet peak demands, there is enough fuel (including fossil fuels, water inflows into hydro lakes and wind) to generate sufficient electricity at all times, and the transmission system can convey the electricity from where it is generated to consumers.

In order to maintain supply, a second-by-second balance between generation and demand must be achieved. An excess of generation causes the system frequency to rise, an excess of demand causes the system frequency to fall. The electricity system is designed and operated in such a way as to cope with both large and small fluctuations in supply and demand.

Instead of backing up each power station with a second power station in case the first suddenly fails, the system operator (Transpower) pools reserves for the whole system. This allows it to respond to a variety of potential events.

Frequency-keeping reserves are used to respond to instantaneous imbalances. The system operator buys sufficient reserves such that system frequency remains near to 50Hz for the continuous demand and generation fluctuations, and within set limits following any sudden tripping of the largest generating units or any sudden disconnection or reduction of demand.

The system operator also requires reserves to meet daily fluctuations in demand. Reserves are particularly valuable at times when large power stations are connecting (or disconnecting) from the system or when demand is changing rapidly. For example, every morning electricity demand increases by several hundred megawatts over two or three hours.

NZ's wind farms do not currently provide frequency keeping and generation reserves. However, recent developments in wind turbine technology mean that new wind farms will be able to offer these services if the system operator and wind farm operators agree how to implement the technology.

WILL OUR ELECTRICITY COST MORE?

Electricity prices are expected to rise, but the costs associated with developing wind generation are expected to be less than the costs associated with continuing to rely on thermal generation. As wind farms in New Zealand receive no subsidies, they are only built when they are expected to generate electricity at a competitive price.

Wholesale electricity prices have risen nearly 60% in real terms since 2000, largely because of increasing gas prices.[3] Between 2008 and 2009 wholesale natural gas prices (which includes gas sold for electricity generation) increased 31.6% in real terms, rising to $6.96 per gigajoule ($/GJ).

The Emissions Trading Scheme, which puts a price on greenhouse gas emissions, is also pushing up the price of electricity from thermal generation, although the exact price impact is not yet clear.

A study lead by Goran Strbac, Professor of Electrical Energy Systems at Imperial College in the UK, and commissioned by Meridian Energy, identified the costs associated with greater use of wind in New Zealand. The study estimated the additional cost of integrating 2000 MW of wind generating capacity by 2020 to be between $2.06 and $2.76/MWh of wind energy. In contrast an increase in the cost of natural gas of $1/GJ equates to an increase in electricity prices of about $8/MWh.

Wind energy is already demonstrating that it is a cost-effective source of electricity generation. As natural gas prices and the cost of carbon emissions rise, wind energy will play an important role in reducing the upwards pressure on electricity prices.

3. Ministry of Economic Development, New Zealand's Energy Outlook 2009 - Reference Scenario (www.med.govt.nz/energyoutlook).

www.windenergy.org.nz

Find out more about wind energy and wind farms in New Zealand at www.windenergy.org.nz.

NZ Wind Energy Association

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The New Zealand Wind Energy Association (NZWEA) is an industry association that works towards the development of wind as a reliable, sustainable, clean and commercially viable energy source. We aim to fairly represent wind energy to the public, government and the energy sector. Our members include 80 companies involved in New Zealand's wind energy sector, including electricity generators, wind farm developers, lines companies, turbine manufacturers, consulting firms, researchers and law firms.

new zealand wind energy association

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2. Goran Strbac and others, Summary of Findings, New Zealand Wind Integration Study, April 2008 (http://www.meridianenergy.co.nz/AboutUs/News/Economic+virtues+of+future+wind+generation.htm)